WisDOT Implementation Plan: 3D Technologies for Design and Construction

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Prepared for the Wisconsin Department of Transportation

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WisDOT IMPLEMENTATION PLAN:
3D TECHNOLOGIES AND METHODS FOR DESIGN AND CONSTRUCTION

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VISION STATEMENT

Adoption of 3D methods and seamless data flows throughout initial survey, design, contracting, construction, as-built survey, payment, and other applications included within the infrastructure lifecycle.

PURPOSE OF THIS DOCUMENT

This plan addresses a management strategy and six initiatives for moving towards realization of the vision statement. Components of the initiatives are either underway within WisDOT or proposed herein and relate directly to three-dimensional technologies and methods. The objectives of the plan are to establish or reiterate justifications for the initiatives, identify relationships among them, coordinate among the initiatives where appropriate, recommend actions that will help realize synergistic benefits, assign priorities, establish or reiterate milestones and timelines, and identify responsible parties.

SUMMARY OF INITIATIVES, GOALS, EFFORTS, PRIORITIES, AND LEAD SECTIONS

Initiative	Goal	Effort	Priority
Height Modernization and CORS - Lead: BTS (Surveying and Mapping)			
	Internal / External Support Groups Secure Funding	High	High
	Implement 5-Year Completion Plan (2009-2013)	High	High
DTM Data Collection and Analysis - Lead: BTS (Surveying and Mapping)			
	Fill Survey Data Coordinator Positions	Moderate	High
	Determine Map-Check Frequency	Low	Medium
	Revise FDM and Business Practice for Map Checks	Moderate	Medium
	Develop Standards and Procedures	High	High
	Pilot Standards and Procedures	Moderate	High
	Impl Stds, Procs, Training on DTM Data Collection	Moderate	High
	Implement DTM-to-DTM for Earthwork	Moderate	High
	Evaluate Technologies (e.g., LiDAR, Aiborne GPS)	Low	High
3D Design Process - Lead: BPD (Roadway Standards and Methods)			
	Existing Civil 3D Pre-Deployment Plan	Moderate	High
	Civil 3D New User Training	High	High
	Develop and Execute Extended Deployment Plan	Moderate	Medium
	Annual Users Conference Process	High	Low
	3D Model Content and Format Standards	High	High
	Establish Date for 3D Models for PS&E	Low	High
	Evaluate 3D Models as Construction Contract Docs	High	Medium
Automated Machine Guidance - Lead: BPD (Project Services)			
	Monitor and Refine Grading Specification	Low	High
	Develop, Pilot, and Implement Base Course Spec	Moderate	High
	Investigate and Evaluate Need for Paving Spec	Moderate	High
	Study Bridges & Utilities and Make Recommendation	Low	Medium
Field Technology and Inspection - Lead: BPD (Project Services)			
	Rovers-for-Construction Group		
	Investigate Scenarios and Feasibility	Moderate	High
	Pilot, Evaluate, and Develop Implementation Plan	High	TBD*
	Execute Implementation Plan	High	TBD*
	Inspection Automation Group		
	Investigate Feasibility	Moderate	High
	Develop Implementation Plan	High	TBD*
	Execute Implementation Plan	High	TBD*
Infra. Lifecycle Uses of 3D Data - Lead: 3D Technologies Management Group			
	To Be Developed		

TBD*: To be determined by preceding feasibility study.

INITIATIVES

1. Height Modernization Program (HMP) and Continuously Operating Reference Stations (CORS).

Background: WisDOT's height modernization program was initiated in 1998 with funding from the National Oceanic and Atmospheric Administration / National Geodetic Survey (NOAA / NGS) to densify and improve the vertical component of Wisconsin's geodetic control network. HMP is installing a hierarchical network of monumentation and measurements that includes the existing high-accuracy reference network, and new primary, secondary, and local stations. Measurements include static Global Positioning System (GPS) and high-order differential leveling. The network is being installed in eight phases, working from south to north and east to west, then back east across the state (see Appendix A). Phases 1-5 are complete with published coordinates. Phases 6-7 are underway with monumentation and measurements. Phase 8 (northeastern Wisconsin, Green Bay to Ashland and including Door County) will have decreased monumentation with no secondary or local stations due to the advent of CORS.

CORS is an on-going WisDOT / NOAA project to construct a network of continuously operating reference stations in Wisconsin to support real-time kinematic (RTK) GPS applications with 3D positional accuracies at the 2cm level in real time. WisDOT's Geodetic Survey Unit partnered with other state and local government agencies, as well as educational institutions on development and implementation of the system. Through cooperative agreements, partners have and continue to contribute facilities, power, Internet access, and possible GPS hardware to the program. WisDOT has supplied most of the GPS hardware; all of the GPS software components; nearly all of the supplies and materials to construct the CORS monuments; and all information technology (IT) components to operate the system.

CORS sites include public educational buildings, county facilities, municipal facilities, and a park. The network will be operated and controlled by GPS network software running on servers in Madison. CORS data are archived and made available for post-processing applications (e.g., airborne GPS).

The network (defined by an area known as Zone 1 (see Appendix B)) was set operational in July, 2008. Zone 1 consists of 24 permanent CORS sites, east of a line from Marinette to Shawano to Fond du Lac to Beaver Dam to Janesville. Construction of Zone 2 is underway. Zone 2 consists of 13 permanent CORS sites located just west of Zone 1 from Madison to Rhinelander. As of December, 2008, there were 130 subscribed users, including some from out of state. Applications range from geodetic and land surveys to precision agriculture. CORS is becoming part of the infrastructure of Wisconsin and is being viewed by some as having the role of a utility.

At least eight more CORS will be built during 2009. The location of Zone 3 is tentatively planned just west of Zone 2 from the Illinois border to central Wisconsin. Zone 4 would possibly include as many as 18 CORS in north central Wisconsin (if grant funding is available). Funding for HMP and CORS development comes from NOAA / NGS with some matching funds from WisDOT. The effort is currently operating on a federal fiscal year 2007 grant of $1,200,000 that ends in March, 2009. Approval has been received for a $300,000 federal fiscal year 2008 grant that will start in April, 2009. An application has been submitted for a $2,450,000 federal fiscal year 2009 grant. During the current fiscal year, WisDOT provided matching funds for purchase of receivers and hiring of consultants to perform field and office activities.

Issues: Many of the other initiatives and efforts described within this document require successful completion of HMP and CORS to fully realize their potential benefits. Some assume an operational CORS network in order to be technologically or economically viable.

- There is uncertainty with future grant funding.
- Problems with remote access to GPS receivers need to be resolved. These involve host site IT security issues that must be addressed to avoid maintenance and upgrade visits to each CORS station.
- An overall maintenance plan for the network needs to be developed that addresses, among other things, means for staying abreast of and exploiting technological advances over time.
- Operation of system software needs to be learned by several individuals.
- Additional staff will be needed to support CORS when it is complete. There is a strong IT / communications technical component in addition to a public relations component.

Stakeholders: Design and construction project engineers, planners, surveyors, photogrammetrists, contractors, utilities, staking contractors, and numerous external groups that require high-precision positioning services (e.g., precision agriculture).

Recommendations: Given the significance of HMP and CORS to effective, efficient, and consistent use of 3D technologies throughout design and construction and the uncertainty of funding for the long-term viability of HMP and CORS, we recommend:

- Developing a WisDOT support group that advocates internally for sustained resources throughout WisDOT for the HMP and CORS efforts.
- Advocating formation of an external users group that works for sustained support at the local, state, and national levels for the HMP and CORS efforts by communicating the importance of the technology and how it will benefit their business needs.

Short-Term Goals (1-2 years):

- Raise the awareness of management and upper management within WisDOT of the significance of HMP and CORS to the overall mission of the department and to the State of Wisconsin.
- Ensure continued federal and departmental funding.

Long-Term Goals (beyond 2 years): Assuming sustained current levels of funding, both HMP and CORS are on a 5-year completion plan (2009-2013). Without implementing the two above recommendations, the assumption of sustained funding is, at best, tenuous. Even with implementation of the recommendations, the assumption of sustained funding is uncertain. Ultimately, the long-term goal is not only completion of HMP and CORS but also sustaining them as operating systems servicing a host of internal and external users.

Timeline: The first recommendation should be implemented by April, 2009 (start of new funding cycle). The second recommendation should be on-going and, in addition, should become part of the charge of the internal support group formed under the first recommendation.

Relative Levels of Effort:
- Securing sustained funding - High.
- Implementing the 5-year completion plan – High.

Priorities:
- Securing sustained funding - High.
- Implementing the 5-year completion plan – High.

Benefits: Although HMP and CORS are integral to full success of the overall 3D initiatives, they have been and can be justified on their own merits.
- CORS eliminates the need and cost for local base station GPS receivers.
- CORS eliminates resource time associated with equipment setup at the base site.
- CORS ensures reliability and redundancy in position determination.
- CORS and HMP greatly enhance consistency of coordinate determination, facilitating corridor control development.

Relationships with Other Initiatives: Through the benefits outlined above, HMP and CORS have direct linkages to automated machine guidance (Initiative 4), DTM data collection (Initiative 2), and inspection (Initiative 5). In addition, facilitation of consistent corridor control and minimization of problems with project control is supportive of the entire set of processes addressed by this plan.

Lead Section: Bureau of Technical Services – Surveying and Mapping Section.

2. Digital Terrain Model (DTM) Data Collection and Analysis.

Background: Original ground and final DTMs are developed by 1) WisDOT's Photogrammetry Unit, 2) consultants using photogrammetry, 3) WisDOT survey field crews, and 4) consultants using ground survey methods.

Field crews and consultants receive guidance from region survey coordinators. The Facilities Development Manual (FDM) contains a short section on procedures for DTM collection (ground survey and photogrammetric). This section defers to field procedures for collecting cross sections as these are what are currently required for design and often used for computing final earthwork quantities. The master contract special provisions for photogrammetric services contain a brief statement on procedures. The Construction and Materials Manual (CMM) contains many references to cross sections and methods that use cross sections.

The FDM contains a section on accuracy standards for photogrammetric products. It does not contain an accuracy standard for ground survey products. The master contract special provisions for photogrammetric services contain a brief statement on required accuracies. WisDOT practice for photogrammetric contracting has been to require that products meet specified accuracies and to remain silent on details of procedures. Map checks are performed on some products to ensure conformance to accuracy requirements.

As standard practice, final earthwork quantities are currently determined from cross-sections by average-end-area. In actual practice, a variety of methods are used by consulting engineers and contractors to compute earthwork. If the data are collected appropriately, DTM-to-DTM methods should be more accurate than average-end-area because they use more complete representations of the original ground and final surfaces. Moreover, final DTMs are sometimes developed from survey data, then sliced into cross-sections to use with the prescribed average-end-area method of computation. Final DTMs are a primary input to the envisioned 3D as-builts (see Initiative 5).

Issues:

- The need for survey data coordinator positions was justified and approved by the Project Development and Technical Services Chiefs prior to this initiative and stands on its own merits. However, the positions need to be elevated on the critical fill list.
- The FDM needs modification to place emphasis on DTM data collection as opposed to cross section data collection.
- The CMM needs revision if utility of cross sections is to be decreased in favor of DTM methods.
- Ground survey data collection is sometimes iterative with crews needing to return to the field after the designer decides that data are too sparse (completeness and accuracy are different issues).
- Map checks of photogrammetric products are infrequent.
- The software mechanisms for creation of DTMs from survey data are not well understood by field and office personnel.
- There is lack of consensus on accuracies required for original ground and final DTMs.

- There is need for both in-class and on-the-job training for both data collection and analysis.
- There are relevant technologies (e.g., airborne GPS, LiDAR) that have not been fully investigated by WisDOT. Applications extend beyond DTM data collection.

Stakeholders: Design and construction project engineers, surveyors, photogrammetrists, and contractors.

Recommendations:
- Continue implementation of survey data coordinator positions.
- Determine the desired frequency of map checks and incorporate in FDM and business practices.
- Appoint a stakeholder advisory group to address the following:
  - Standards and procedures for collection of original ground and final DTMs to ensure consistency, accuracy, and cost-effectiveness in results whether the methods are photogrammetric or ground survey. This includes review and revision of existing standards documents and coordination with Initiative 5 for final DTMs as inputs to 3D as-builts.
  - Development and implementation of training on:
    a. Software methods for creation of DTMs from survey data (i.e., understanding the algorithms).
    b. Means for survey coordinators to better communicate procedures and expectations to survey crews to reduce the frequency of returns to the field.
    c. Use of DTM-to-DTM methods for computing earthwork quantities.
  - Rapidly-evolving data collection technologies (e.g., LiDAR, advanced softcopy photogrammetric methods, integrated GPS/IMU (with CORS)) and their appropriate uses, to include coordination with efforts beyond DTM data collection.

Short-Term Goals (1-2 years):
- Fill regional survey data coordinator positions.
- Achieve consistency in map-check frequency.
- Refine or develop, then pilot, DTM data collection standards and procedures. Revise standards documents accordingly.
- Develop, provide training, and implement use of DTM-to-DTM methods for earthwork computations. Revise standards documents accordingly.

Long-Term Goals (beyond 2 years):
- Implement DTM data collection standards and procedures.
- Provide training on procedures for DTM data collection.
- Evaluate technologies (e.g. LiDAR and airborne GPS) that might increase the efficiency of accurate DTM data collection.

Timeline, Relative Levels of Effort, and Priorities:

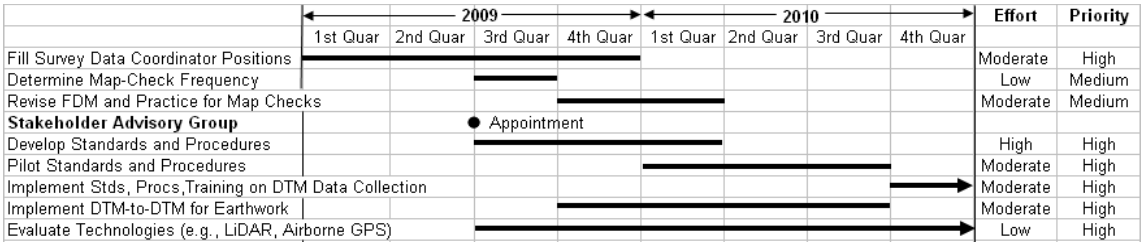


Figure 1. Short-Term Timeline for DTM Data Collection and Analysis Initiative

Benefits:

- The survey data coordinator positions will facilitate the flow of 3D information between design and construction and provide assistance with development and implementation of standards and procedures for data collection.
- Consistency in map-check frequency will increase confidence in use of photogrammetric DTMs.
- Standards, procedures, and associated training will ensure consistency in original ground and final DTM completeness and accuracy and reduce revisits to the field for further data collection.
- If the data are collected appropriately, use of DTM-to-DTM methods should not only lead to better results, it might also reduce the number of disputes over final quantities.

Relationships with Other Initiatives: The original ground DTM is a primary input to the design process (Initiative 3). Final DTMs are primary inputs to 3D as-builts (Initiative 5) and, as such, have infrastructure lifecycle uses (Initiative 6). Data collection for the original ground DTM will benefit from HMP and CORS (Initiative 1) by elimination of the need for local RTK GPS base stations and by reduction in problems with project control.

Lead Section: Bureau of Technical Services – Surveying and Mapping Section.

3. 3D Design Process.

Background: WisDOT's Methods Development Unit has a detailed plan for the initial deployment of Civil 3D, including tasks, milestones, and timelines. The plan addresses hardware upgrades, design products, workflows, and phased-in training. The initial objective is replacement of CAiCE with Civil 3D as the primary design platform, with the transition occurring over a 3-5 year period. Initially, some designs started in CAiCE will be converted and completed in Civil 3D. Eventually, all designs will be developed completely with Civil 3D. There is no pre-determined termination date for CAiCE. Ultimately, more extensive use of Civil 3D, for example in field surveys, photogrammetry, drainage, and impact analysis for environmental documentation, is expected as future enhancements to the software provide more robust functionality beyond design. Initial training of new users on Civil 3D is expected to begin during mid to late summer of 2009.

Moreover, 3D design is a process, not a technology. A number of software packages support the 3D design process and engineering design consultants might be using any of these software packages. One of the challenges is to establish technology-independent standards and procedures for 3D design and its products.

Issues:

- There are retraining implications for keeping current with software advances.
- The initial deployment plan for Civil 3D does not address its full range of functionality. In addition, future enhancements by the vendor will need to be considered. Impacts of technology changes, upon both internal and external users must be addressed.
- Future modifications to plans as the primary design deliverable should be evaluated. For example, consider the possible adoption of 3D models as contract documents and retention or elimination of two-dimensional views. There are questions concerning the required level of detail and accuracy of 3D models and which projects should be initially targeted.
- 3D model content and generic format standards are needed to address data exchange and downstream uses such as automated machine guidance, inspection and final quantities, and infrastructure lifecycle uses of 3D technology.

Stakeholders: Design and construction project engineers, CAE Advisory Group, CADD Users Group, real estate managers, utility companies, access control managers, contractors and consultants, vendors and software developers, surveyors, local governments and state and federal agencies.

Recommendations:

- Continue implementation of survey data coordinator positions.
- Execute the existing Civil 3D deployment plan and develop an extended deployment plan.
- Appoint a stakeholder advisory group on enhancement of design deliverables to address:
    - Conduct of annual statewide 3D design users' meetings.
    - Development of 3D model content and generic format standards.
    - Evaluation of 3D models as contract documents.

Short-Term Goals (1-2 years):

- Deployment of Civil 3D according to existing plan, with consideration of need for consultant training.
- Development and execution of an extended deployment plan for 3D design.
- Development and implementation of annual statewide 3D design users' conference process. This goal is part of the charge to the study group.
- Development of non-proprietary 3D model content and format standards by the study group.
- Establishment of a date when consultants will be required to provide 3D models as a PS&E deliverable.

Long-Term Goals (beyond 2 years):

- Continued execution of the extended deployment plan for 3D design.
- Evaluation of 3D models as construction contract documents by the advisory group.

Timeline, Relative Levels of Effort, and Priorities:

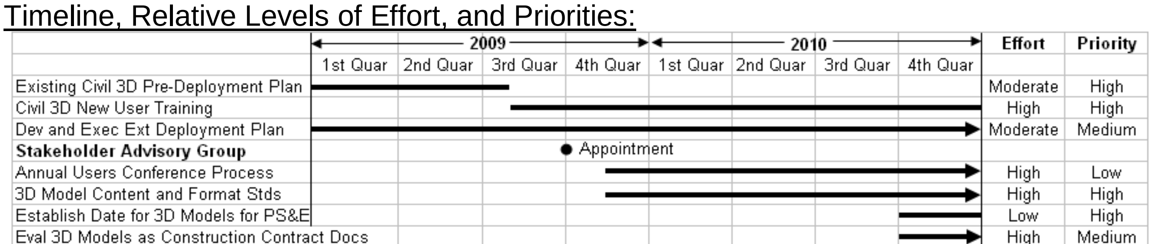


Figure 2. Short-Term Timeline for 3D Design Process Initiative

Benefits:

- Adoption of Civil 3D as WisDOT's primary design tool has been previously justified and stands on its own merits (CAiCE Replacement Recommendation Report, WisDOT, 2007).
- The benefit of developing and adopting an extended deployment plan addressing the 3D design process is a statewide increase in production capabilities and efficiencies as the technology rapidly increases in power and functionality.
- An annual users conference will provide a forum for information exchange to the benefit of all involved and a possible mechanism (e.g., through workshops) for the study group to pursue its other goals.
- Standards for 3D model content will facilitate uniformity in data sets shared among parties, reduce duplicative data development, reduce conflicts in data interpretation, and level the playing field of data expectations.
- A generic data exchange standard will increase efficiencies in utility of data shared among parties and reduce redundant data development.
- Generating 3D models as design outputs and providing them directly to contractors will eliminate the need to develop them, through "reverse engineering", from 2D plans, thus reducing the greatest technological impediment to wider and more effective use of automated machine guidance for construction.

Relationships with Other Initiatives: Primary input data to the design process include the original ground DTM (Initiative 2). Design outputs are required for automated machine guidance (Initiative 4), inspection (Initiative 5), and infrastructure lifecycle uses of 3D technology (Initiative 6).

Lead Section: Bureau of Project Development - Roadway Standards and Methods Section.

4. Automated Machine Guidance (AMG).

Background: WisDOT is nearing completion of a 2.5-year effort to develop a statewide specification for automated machine guidance (AMG) for grading operations. 2008 was the second and final year of pilot projects related to the specification development effort. The developed statewide specification gives contractors the option to use AMG in their grading operations. Use of AMG is not mandated on WisDOT projects. Starting with December 2008 lettings, WisDOT will include the new AMG specification for grading (as a special provision) on all WisDOT projects that have the construction staking subgrade item. The new AMG specification for grading will be included in the 2010 version of WisDOT's standard specifications and, then, will no longer need to be included as a special provision.

Issues: A message received from pilot project contractors is that they would like to have the 3D design model become a design deliverable. Current practice requires contractors to either acquire 3D models from designers if they are available or reverse-engineer model data from traditional plans and staking data. WisDOT is taking steps to remedy this with Civil 3D implementation (Initiative 3).

WisDOT wants to continue to refine the AMG specification for grading as needed. The department also desires to build upon the experience of the AMG grading specification to develop new AMG specifications for base course placement, paving, and perhaps utilities and bridges.

Stakeholders: Design, construction, contractors, consulting engineers, model developers, staking contractors, utility companies.

Recommendations:

- Grading, Landscaping, Sewer Tech Committee develops and implements a plan for monitoring and refinement of the AMG specification for grading.
- Appoint stakeholder advisory groups to develop AMG specifications for base course placement and paving. AMG for paving might include laser augmentation for increased vertical accuracies.
- Appoint a stakeholder advisory group to investigate implications of AMG for utilities and bridges to include which would be easiest to adopt. AMG for utilities might include articulated machinery for excavation.

Short-Term Goals (1-2 years):

- Monitoring and refinement of the AMG specification for grading.
- Development, testing, and implementation of an AMG specification for base course placement.
- Investigation and evaluation of need for an AMG specification for paving.
- Initiation of AMG specification development for bridges and / or utilities.

Long-Term Goals (beyond 2 years):

- Development and implementation of AMG specification for paving.
- Monitoring and refinement of AMG specifications for grading, base course placement, and paving.
- Implementation of AMG specifications for utilities and bridges.

Timeline, Relative Levels of Effort, and Priorities:

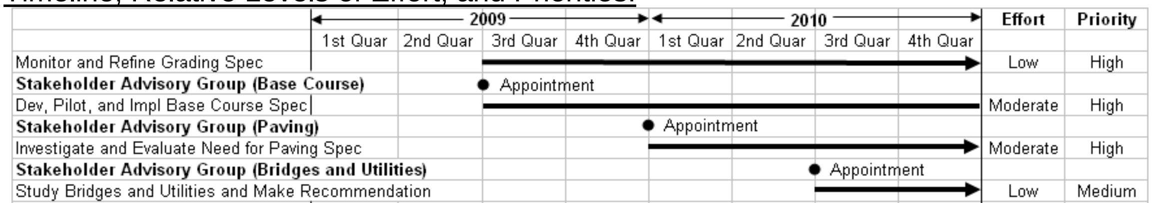


Figure 3. Short-Term Timeline for Automated Machine Guidance Initiative

Benefits:

- Contractors report 20%-40% productivity gains from automated machine guidance for grading.
- Increased uniformity of construction.
- At least one state DOT has reported lower than expected bids as a result of contractors using AMG.

Relationships with Other Initiatives: Automated machine guidance requires a 3D model of the design (Initiative 3). There is a potentially strong direct benefit from HMP and CORS (Initiative 1), through elimination of the need for an RTK GPS base station (NOTE: CORS support for automated machine guidance has not yet been successfully demonstrated in Wisconsin. Tests are currently being conducted by the technology vendor).

Lead Section: Bureau of Project Development - Project Services Section.

5. Field Technology and Inspection.

Background: Construction project staff typically do not have access to GPS and electronic automated inspection technology. Consequently, they conduct surveys, perform inspections, make measurements, determine quantities, keep records, and prepare as-builts with obsolete technology and methods that are time consuming and costly.

NYSDOT has used 3D models, methods, and GPS-based inspection automation technology to reduce the overall cost of construction staking, inspection, and determination of quantities. Currently there is no department-wide program in WisDOT that is actively pursuing this use. There is potential for significant savings in time and costs.

Issues:

- Development and retention of knowledge and skills base among many project engineers.
- Lack of standard approaches to data collection and analysis among regions and among consultants.
- Lack of field equipment and software.
- Failure to exploit emerging inspection automation technology in a comprehensive manner.
- Current as-builts are 2D paper plans that are marked with revisions by project engineers. Such products and methods cannot realize the potential benefits flowing from the availability of 3D electronic as-builts.

Stakeholders: Contractors, project engineers, engineering consultants, surveyors, ACM Users Group, Methods Development Unit, and downstream users of data flowing from the construction process.

Recommendations: Appoint two stakeholder advisory groups:

1. Rovers-for-Construction Group – Investigates alternatives for implementing GPS technology for construction measurements, determines their feasibility, and, if found feasible, develops a detailed implementation plan. Coordinates with the DTM data collection and analysis group (Initiative 2) and the inspection automation group.

   Two possible scenarios have been preliminarily identified:
   1) Having specialized one- or two-person field crews that perform inspection and as-built surveys for multiple projects in proximity with one another;
   2) Furnishing each project team with the technology and knowledge to perform inspection and as-built surveys with 3D methods and data.

   Advantages of scenario 1 over scenario 2 include reduced numbers of rovers, controllers, and software; less training; and relief of effort on the part of project engineers. Disadvantages of scenario 1 compared to scenario 2 include the need to manage multiple data sets from multiple projects on one technology platform and logistics and scheduling among staking and inspection needs on multiple projects.

There are three possible providers of the technology: 1) WisDOT, 2) contractors, and 3) consultants.

2. Inspection Automation Group – Investigates the feasibility of adopting inspection automation technology, and, if found feasible, develops a detailed implementation plan.

   "Inspection automation technology" has broad scope and includes in-field record-keeping technologies such as electronic notebooks and personal digital assistants (potentially wireless) and associated software. Such technologies can be capable of supporting or assisting, for example, development of final DTMs, location-based materials testing and records keeping, development of 3D as-builts by manipulation of 3D design models and inclusion of final DTMs, development of attribute databases linked to 3D models, and querying and reporting from such databases for purposes such as final quantities computation and acceptance of construction products.

Short-Term Goals (1-2 years):

- Completion of feasibility studies for rovers-for-construction and inspection automation.
- If found feasible, completion of detailed implementation plans to include evaluation and piloting for rovers-for-construction and inspection automation.

Long-Term Goals (beyond 2 years):

- Implementation of rovers-for-construction, if feasible.
- Implementation of inspection automation, if feasible.

Timeline, Relative Levels of Effort, and Priorities:

	2009				2010				Effort	Priority
	1st Quar	2nd Quar	3rd Quar	4th Quar	1st Quar	2nd Quar	3rd Quar	4th Quar		
Rovers-for-Construction Group					● Appointment					
Investigate Scenarios and Feasibility									Moderate	High
Pilot, Evaluate, and Develop Implementation Plan									High	TBD*
Inspection Automation Group					● Appointment					
Investigate Feasibility									Moderate	High
Develop Implementation Plan									High	TBD*

Figure 4. Short-Term Timeline for Field Technology and Inspection Initiative

TBD*: To be determined by preceding feasibility study.

Benefits:

- More rapid completion of finals.
- More efficient flow of information.
- Improved staff efficiencies.
- Shift of focus from record-keeping to project oversight.

Relationships with Other Initiatives: Inspection depends upon data from 3D design (Initiative 3), and original ground and final DTMs (Initiative 2). Technology costs and costs associated with project control problems are lowered by HMP and CORS (Initiative 1). Inspection data have infrastructure lifecycle uses (Initiative 6).

Lead Section: Bureau of Project Development – Project Services Section.

6. Infrastructure Lifecycle Uses of 3D Data.

Background: This initiative includes use of as-builts and other 3D data by utilities, surveys, permits, right-of-way, operations, maintenance, planning, and all other activities that occur on the highway right-of-way throughout the infrastructure lifecycle. A primary source of these data would be design and construction processes. An emerging source may be through the use of LiDAR technology.

WisDOT's Division of Transportation Investment Management (DTIM) – Data Research and Technology Unit is examining the potential of implementing vehicle-based LiDAR technology in conjunction with their photo-log work. Photo-log data are currently collected on a 2-3 year cycle. Design, construction, and other lifecycle uses of these data need to be explored

Issues:

- Private utility companies have significant liability concerns with providing 3D data on their facilities.
- Utility companies would not rely on as-built 3D models for utility work (permit work) between or unrelated to WisDOT road construction. They would be considered obsolete and of little value, unless continuously maintained, due to potential for subsequent grade changes, right-of-way changes, and other utility installations.
- External users need a point-of-contact for WisDOT information. Will this continue to be at the regional level or will it be managed centrally?
- It would be very beneficial to be able to assign feature classes and feature intelligence to 3D models. This would facilitate linkages to municipal databases used to manage various components of local government infrastructure. Data volumes will be very significant.
- There is need for continued communication with users of 3D data to identify and attempt to meet their data needs.
- How does the 3D effort coordinate with Wisconsin Local Roads (WISLR)?
- WisDOT Bureau of Highway Operations (BHO) has no specific plans for implementing 3D technologies. Given their large number of potential uses of 3D as-builts, BHO should be represented in the 3D Technologies Management Group (see below).
- The WisDOT Structure Maintenance Section should be contacted as a potential post-construction user.
- Similar to HMP and CORS, there is a need to make other functional areas aware of vehicle-based LiDAR uses.

Stakeholders: Utility companies; federal, state, and local government; planners; traffic and maintenance engineers, surveyors; and all other users of data throughout the infrastructure lifecycle beyond design and construction.

Recommendations:

- Include a representative from BHO in the 3D Technologies Management Group (see below).
- Before July 1, 2009, appoint an advocacy group to support and promote DTIM's investigation and potential implementation of LiDAR in conjunction with photo-log.

- The 3D Technologies Management Group should keep this initiative on its agenda and take appropriate action, as necessary, to foster infrastructure lifecycle uses of 3D data.

Benefits:

- More efficient right-of-way management from, for example, placement of utilities in clusters more proximal to one another.
- Fewer mistakes and change orders.
- Accurate information more readily available for planning, design, and assessment of projects.
- Increased ease of updating and improvement of on-hand data.
- Greater accountability.
- Various users would benefit from 3D models and DTMs for original ground, design, construction, and post-construction as-builts. Some potential uses include:
  - Utilities: Planning, design, and construction of utility relocations related to roadway projects.
  - Local Government: Tracking ownership and easements; notification of property owners and utilities; and planning, design, and assessment of projects.
  - WisDOT Traffic Operations: Traffic engineering and safety with data needs including sign location and dimensions; poles – signals and lighting; underground conduit and cable; utility locations; location of pavement surface; edge of travel lane; outside edge of shoulder; structure clearances; and lateral clearances to obstructions, parapets, and other objects.
  - WisDOT Maintenance: Permitting, advertising sign placement, roadside management, no-mow zones, scenic easements, roadside design, roadside facilities, shoulder maintenance, and Compass reviews.
  - WisDOT Planning: Maintenance and updates to the primary departmental GIS spatial database (State Trunk Network (STN)) and, potentially, the Local Roads GIS spatial database (WISLR).

Relationships with Other Initiatives: Infrastructure lifecycle business functions will make use of original ground DTMs (Initiative 2), 3D design models (Initiative 3), and 3D as-builts and inspection data (Initiative 5). Planning and utilities data are inputs to the design process (Initiative 3).

Lead Group: 3D Technologies Management Group (see below).

DEPENDENCIES AMONG INITIATIVES AND GOALS

Relationships among initiatives were identified in previous sections of this plan. Some of these relationships are deep enough to be considered dependencies. That is, successes of some of the initiatives, in part or in whole, depend upon attainment of goals within other initiatives. In other cases, there are dependencies among goals within the individual initiatives themselves. These dependencies are considered distinct from the priorities assigned to the goals. For example, a pair of goals might have the same priority even though one of them cannot be met without previous or parallel attainment of the other. Also, the activities recommended to achieve dependent goals can sometimes be carried out in parallel or with overlap in their timelines.

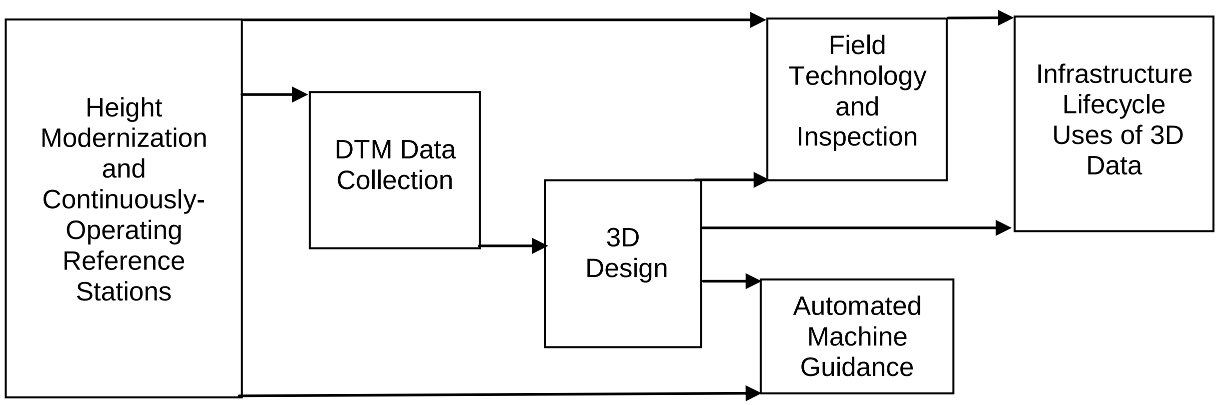
Figure 5 is a high-level depiction of dependencies among initiatives. Figure 6 is a more detailed depiction of primary dependencies among goals within the initiatives. This overall plan has described the goals in Figure 6, as well as other independent, or more moderately dependent, goals not shown in Figure 6.

MANAGEMENT STRATEGY

Implementation Management, Coordination, and Outreach.

Background: Recommendations associated with Initiatives 1-6 call for creation of seven stakeholder advisory groups and three support groups with outlines of charges and timelines for completion of their work. A number of other activities are also recommended to be undertaken by various units within WisDOT.

Issue: The work of these groups and the other activities need coordination, support and advocacy, reporting mechanisms, and means for outreach.



NOTE: An arrow indicates that if goals of the antecedent initiative are not met, then benefits of the subsequent initiative will be diminished.

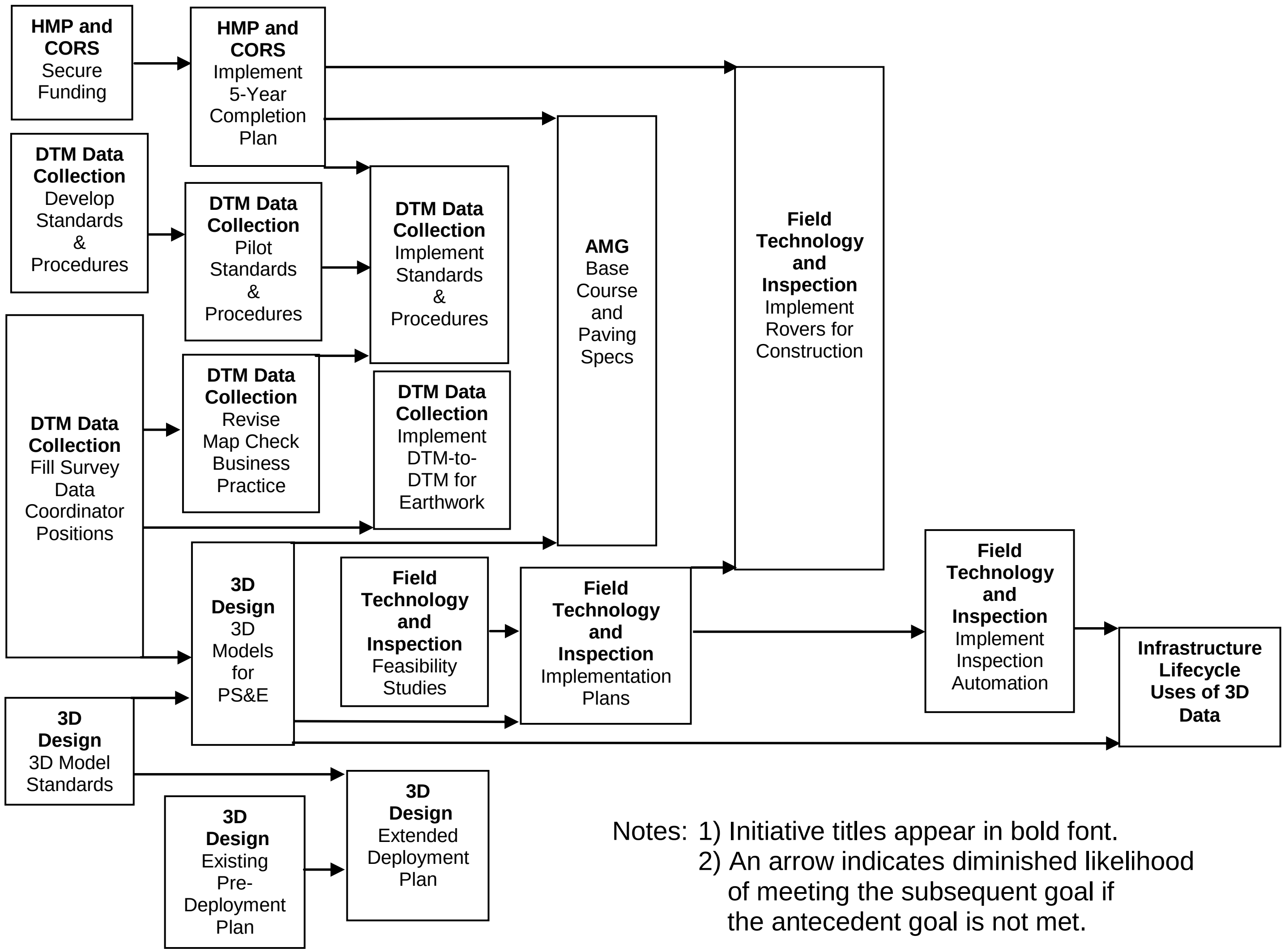
Figure 5.
Initiative Dependency Diagram

Recommendations:

- Appoint a 3D Technologies Management Group, chaired by a bureau director, that keeps abreast of and coordinates the activities recommended in this plan, provides a reporting structure for the recommended groups and activities, keeps upper-level management informed of progress, advocates for the overall effort, and develops outreach mechanisms to keep the broader design and construction communities aware of and involved in the recommended activities.
- The Management Group should include at least one representative from each of the six initiatives.
- This implementation plan should be revisited and updated at least annually by the Management Group.

Timeline: The recommended 3D Technologies Management Group should be appointed no later than July 1, 2009. The Group should remain functional until completion of the activities recommended within this plan.

Responsible Party: The Director of the Bureau of Project Development for appointment of 3D Technologies Management Group.

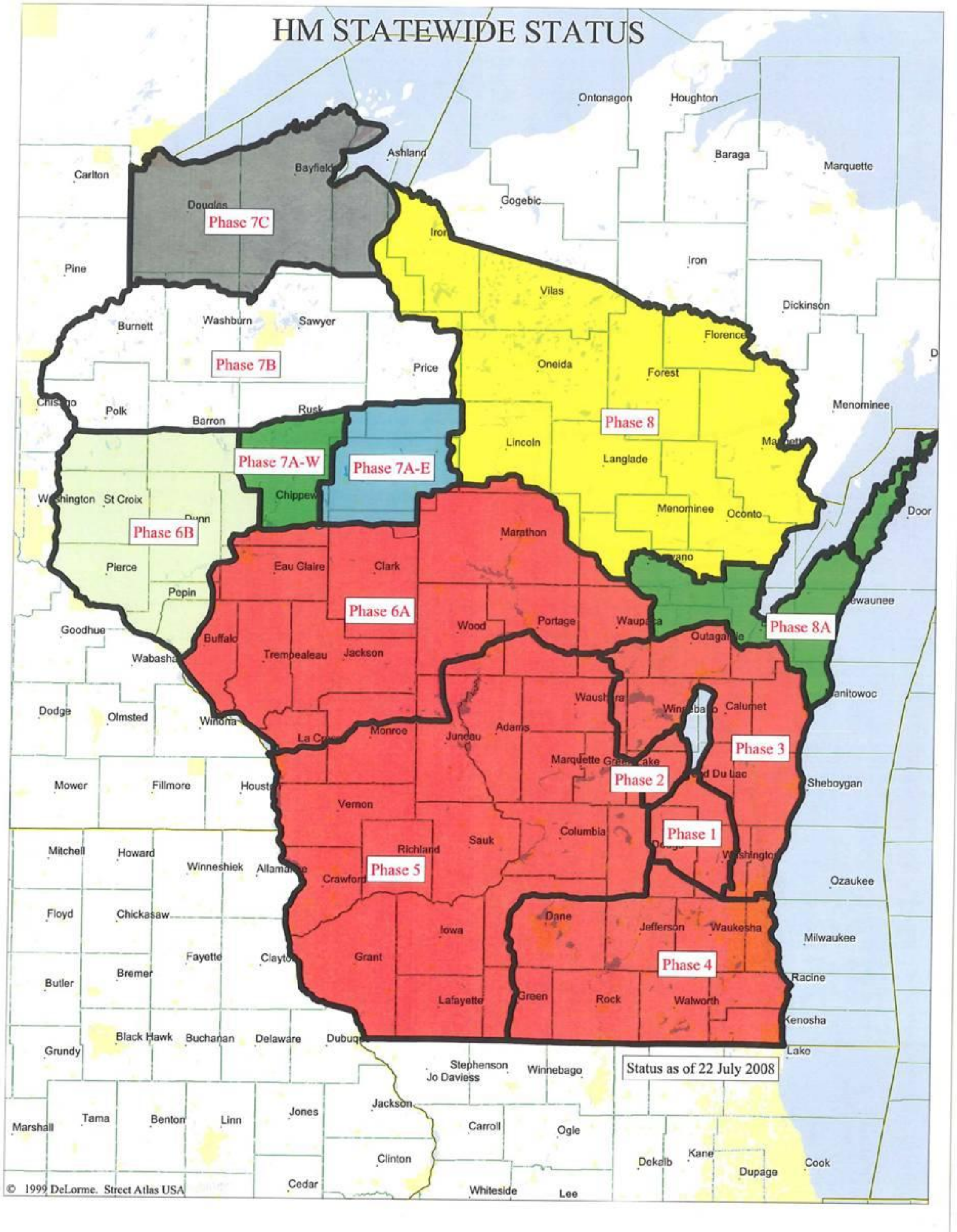


Notes: 1) Initiative titles appear in bold font.
2) An arrow indicates diminished likelihood of meeting the subsequent goal if the antecedent goal is not met.

Figure 6.
Initiative and Goal Dependency Diagram

Appendix A.

Map of Height Modernization Program (HMP) Phases


HM STATEWIDE STATUS
Phase 7C
Phase 7B
Phase 8
Phase 7A-W
Phase 7A-E
Phase 6B
Phase 6A
Phase 8A
Phase 3
Phase 2
Phase 1
Phase 5
Phase 4
Status as of 22 July 2008
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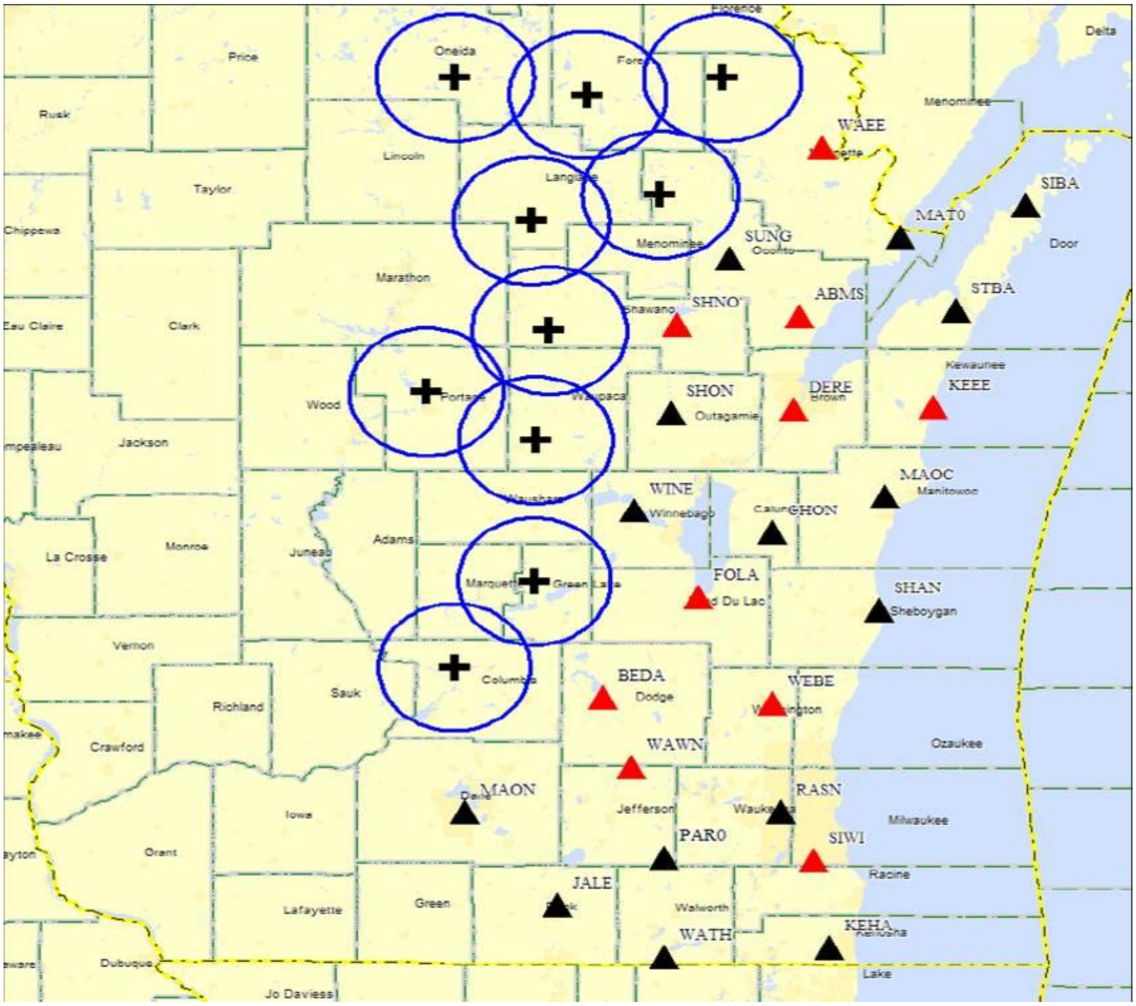
Appendix B.

Continuously-Operating Reference Stations (CORS) Zones 1 and 2



Triangles: Zone 1　　Crosses: Zone 2

The Construction and Materials Support Center (CMSC) is housed in the Department of Civil and Environmental Engineering on the University of Wisconsin-Madison campus. The CMSC was formed in partnership with the Wisconsin Department of Transportation (WisDOT) to focus on implementing research findings within the department and other local, state, and federal transportation agencies. In addition, the CMSC functions as a service and applied research group to deliver timely solutions to construction management and materials engineering problems for a variety of organizations. The mission of the Center is to develop research implementation strategies and tools to help WisDOT, public agencies, and industry rapidly implement new and relevant technologies throughout the project development process. The Center draws upon university expertise to collaborate with department personnel and the private sector to find solutions to problems, minimize delays to construction, and improve the quality and efficiency in which materials are used throughout the construction process. Emphases areas for the Center are:

- Accelerated construction techniques
- Construction project management
- Innovative project delivery processes
- Materials performance and production

The Center is staffed to conduct research, develop tools and techniques to enhance project cost-control and minimize scheduling delays in project construction, identify methods and processes to accelerate project delivery and construction activities, create strategies for departments of transportation and others to implement new techniques and technologies, assess new construction materials and create project specifications.

Services include training staff on new techniques and processes, developing application guidance tools for inclusion in manuals, and holding workshops and seminars. Academic staff incorporate the field applications and lessons learned into undergraduate and graduate level engineering courses taught at the UW-Madison.

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